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SPRAY DEPOSIT DISTRIBUTION

WITHIN BALSAM FIR CROWNS

by

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INTRODUCTION

During aerial application, assessment is usually required to determine if the area has received adequate spray coverage. In operational projects, spray deposit is usually collected on spray cards placed in openings or along roads. Frequently, difficulties are encountered finding adequate openings to assess spray deposit in the vicinity of sample trees. In addition, during pilot tests more precise information is needed on the dispersal of spray droplets in coniferous tree crowns in order to correlate it with larval mortality.

At high population levels, spruce budworm larvae, Choristoneura fumiferana (Clem.), are found in large numbers throughout the entire crowns of balsam fir. After feeding in the upper crown larvae migrate to the middle and lower crowns and continue to feed on staminate flowers, foliage, and buds (Morris 1963). Variation in spray deposit between the various crown levels effects the level of population reduction.

Hurtig et al. (1953) reported that more droplets/cm² were found in the midcrown of spruce and balsam fir on the windward side than in the midcrown or at the dripline (ground level on the leeward side of the trees.

Maksymiuk et al. (1975) found that about twice as many drops were deposited in the forest openings (16.5/cm²) than under the tree canopies (7.9/cm²).

Spray deposit distribution in four balsam fir crown levels was evaluated after single swath aerial application of kerosene (No. 2 fuel oil).

METHODS

LOCATION

The spray area was located in northern Maine within a white spruce-balsam fir forest type typical of areas sprayed for spruce budworm, Choristoneura fumiferana (Clemens). The trees were about 40 feet tall. The area was moderately defoliated during the 1975 season. The spray block was a strip of forest about 100 feet wide and 0.5 miles long, parallel to a logging road (Figure 1).

SPRAY APPLICATION

Deodorized kerosene (No. 2 fuel oil), commonly used as a carrier and solvent of insecticides, was applied with fixed wing aircraft (Grumman^(R) Super Ag Cat).^{1/} The spraying system was calibrated to apply 0.25 gallon per acre at 100 mph airspeed, 35 psi boom pressure and 100 ft swath width. A single swath application was made from 50-75 feet above tree tops with the flight line parallel to the road. Six flat fan nozzles, Tee (R) Jet No. 8008, directed downward and perpendicular to the boom were used in this operation. Fifty-mesh screens were placed inside the nozzles and a 40-mesh screen was used at the pump intake.

Spraying was done at 1130 hours on October 8, 1975. The air temperature was 50°F with 70 percent relative humidity. Wind conditions were from 0 to 4 mph blowing in an easterly direction.

SPRAY DEPOSIT COLLECTION

Spray deposit was collected on 320 standard red Kromekote oil-sensitive spray cards. Thirty-two cards were placed on each of

^{1/} The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

ten sample trees. Each tree was a dominant or codominant balsam fir about 40 feet tall. Eight spray cards were placed in each of 4 levels for each tree:

Upper Crown - about 10 feet from top to tree.

Lower Crown - at the bottom of the live crown usually
8-12 feet from ground.

Mid Crown - in the middle, between the upper and lower crown.

Ground level - on the bare ground.

The arrangement within a crown level was as follows. Four of the eight cards were on the windward side facing the road and the other 4 on the leeward side. Two of the 4 cards were on the periphery of the crown and the other 2 were within a foot of the main stem. At the ground level, cards were placed at the drip line or edge of the tree crown.

The spray deposit cards were held in the tree crowns by specially designed holders of 22-gauge sheet aluminum, 5 inches wide and 10 inches long. About one-third lengthwise the sheet is bent to conform with the slope of the branch. The other end is parallel to the ground. The holders were nailed to the branches, or twigs. Spray cards were held in place with paper clips. A service bucket (cherry picker) was used to place cards in the upper crown (Figure 1). A ladder was used for the lower crown. Spray cards were set out two hours before spraying and collected two hours after spraying.

Spray deposit cards were marked after spraying to show the tree number, crown level and location within the crown. The cards were examined in the laboratory during a period of one week to three weeks after spraying.

The spray deposit was measured by counting the number of droplets in a square inch area marked in the middle of the card. Observation was made under 60X magnification, (binocular microscope), with lateral lighting almost parallel to the surface of the card. Difficulties were encountered about 2 days after spraying when spots became faded. About 50 cards were not analyzed because of the loss of contrast between the oil stain and card surface.

RESULTS

The average spray deposit for all the spray cards was 74.60 droplets/in² (SE_x = + 9.16) and 38.85% coefficient of variation, (Table 1). The droplet density range was from 37.1 droplets/in² (+ 4.2) on tree 10, to 116.0 droplets/in² (+ 20.3) on tree 9. Since the aircraft flew over the trees in a single swath, the spray deposit variation must have been caused by local air currents. Further comparisons of spray deposit within tree crowns are based on paired Student t tests and differences were accepted as significant at the 95 percent level of confidence, unless otherwise indicated.

The average spray deposit per crown level was: upper crown, 99 droplets/in²; middle crown, 94 droplets/in²; lower crown, 78 droplets/in²; and on the ground, 71 droplets/in². The means between the upper 2 crown levels were significantly different from the 2 lower levels, but not between each other within those levels. The lower crown received on the average about 26 percent less deposit than the upper 2 crown levels.

Analysis of spray deposit on the outside of the tree crowns shows significant decrease from the upper half of the tree to the lower half (Figure 2.) A similar trend is seen on the inside of the tree crown, but the differences are not statistically significant.

The windward side of the tree received more deposit than the leeward side (Figure 3). The differences were significant between the upper 2 crown levels, not between other crown levels.

In each crown level there were no significant differences in spray deposit between inside and outside cards and windward vs. leeward side (Figure 4). However, indications are that if the sample was larger, some differences might occur. The leeward, inside crown, cards at the upper and middle crown levels had significantly lighter deposit accepting 90% level of confidence.

There was a significantly higher deposit on cards located on the outside crown of the upper 2 crown levels than outside cards of the lower 2 crown levels of the windward side (Figure 5). The inside cards of the windward ground cards received significantly less deposit than inside windward cards in the upper, middle and lower crown. No significant differences were found between the crown levels on the leeward side.

DISCUSSION

The results confirm general observations reported by Hurtig et al (1953) and Maksymiuk (1963), that the windward side of the crown and the upper half of the crown tends to receive the greatest spray deposit. This means insect kill may be expected to be higher in this area of the crown.

Spray deposit at ground level is lower than in the upper crown, about 40 percent less than the maximum deposit on cards in middle crown, outside and windward side. However, the spray deposit on the ground cards is similar to all leeward side cards and all lower crown cards.

These results are based on a single swath of spray over the sample area. We recommend that a similar analysis of spray droplet distribution be made in an area treated with several swaths side by side to determine the changes in deposition introduced by drift.

SUMMARY

Distribution of spray deposit in balsam fir, Abies balsamea (L) Miller, tree crowns was made after a single swath aerial application of kerosene (No. 2 fuel oil). The average spray deposit for all spray cards was 76.60 droplets/ in², with 38.84% coefficient of variation. The average spray deposit per crown level was 94 droplets/in² on the ground. Comparison of spray deposit within tree crowns shows significant difference at the 95% level of confidence between the two upper crown levels and two lower levels. Significantly less spray was deposited on the outside of the lower half of the tree than the outside of the upper half. Horizontal comparison at each crown level shows no significant difference in spray deposit between inside and outside crowns, and windward vs. leeward sides (90% level of confidence). Vertical comparison shows a significantly higher deposit on cards located on the outside crown of the two upper crown levels than outside cards of the two lower crown levels of the windward side.

Table 1.--Average number of droplets for 32 spray deposit cards placed in each of 10 trees.

TREE NO.	MEAN	ERROR OF MEAN
1	69.1	3.5
2	61.9	8.5
3	75.0	2.1
4	103.5	13.6
5	44.1	8.2
6	108.3	15.5
7	41.2	3.1
8	89.8	18.5
9	116.0	20.3
10	37.1	4.2
AVE.	74.60	9.16

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Figure 1.--Placement of spray cards in the upper crown of a balsam fir.



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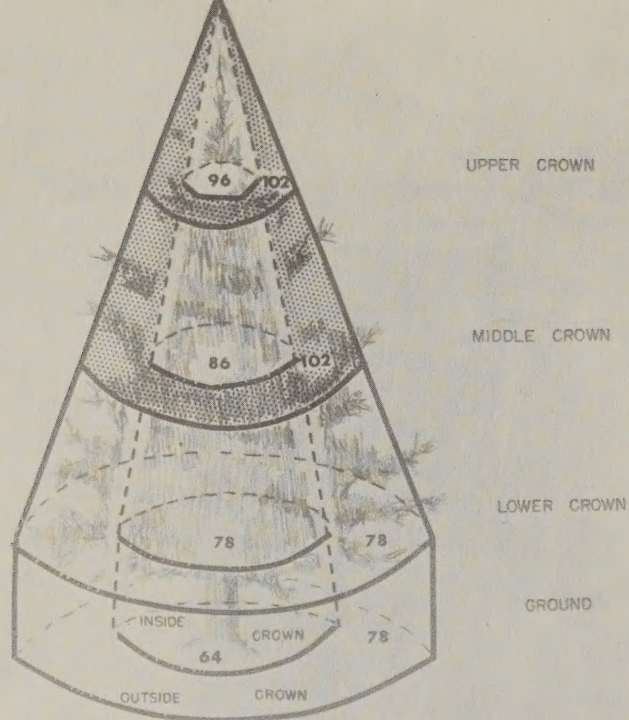


Figure 2.--Comparison of spray deposit (no. droplets/in²) between the 4 tree levels on the inside and outside of the crown. Shaded area is significantly different from the adjoining unshaded crown level (95% conf.).

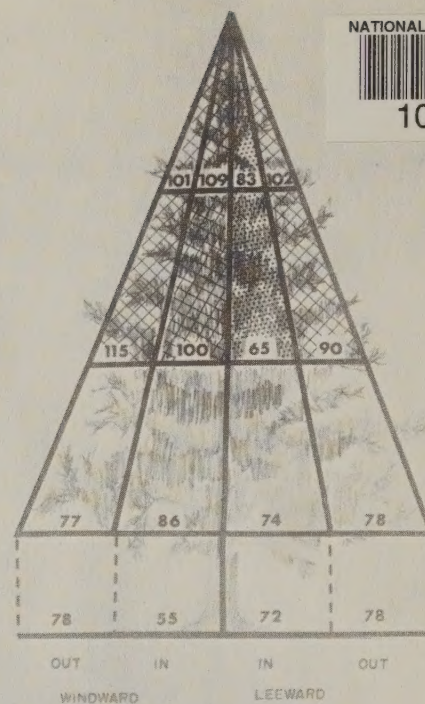


Figure 4.--Comparison of spray deposit (no. droplets/in²) between 4 crown positions at each tree level. Similar shading indicates no significant differences at that tree level at 95% level of confidence. Inside, leeward side, in the upper 2 levels is different from adjoining areas at the 90% level of confidence.

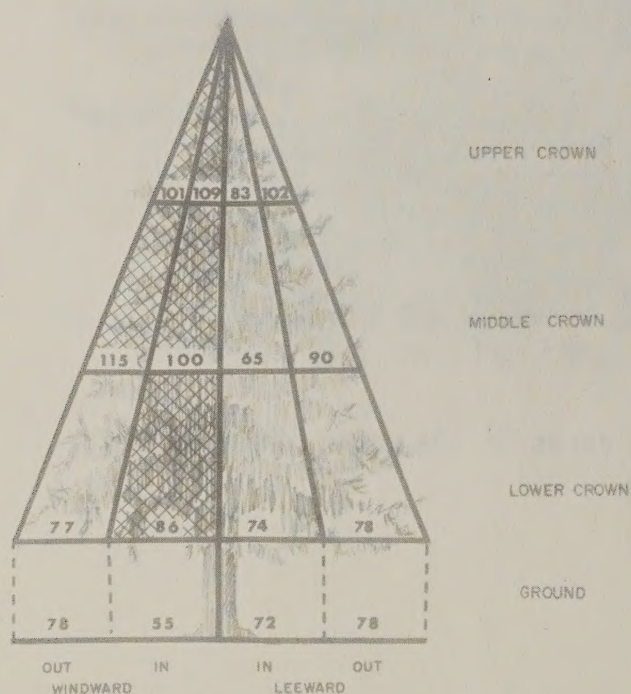


Figure 3.--Comparison of spray deposit (no. droplets/in²) between the 4 tree levels at each of the 4 crown positions. Shaded area is significantly different from the adjoining unshaded crown level (95% conf.).

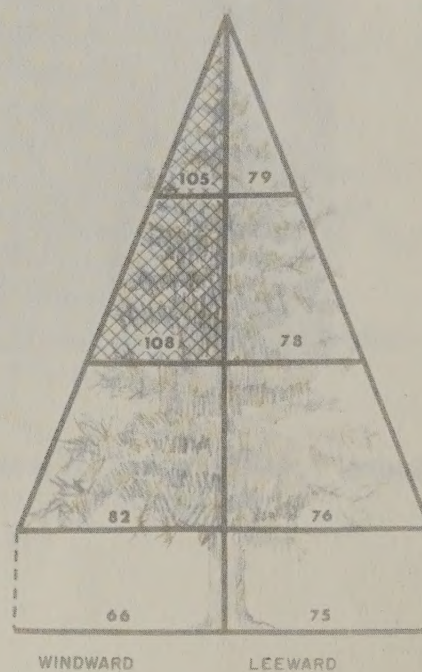


Figure 5.--Comparison of spray deposit (no. droplets/in²) between the windward and leeward sides at each tree level. The shaded area is significantly different from adjoining lateral unshaded area (95% conf.).